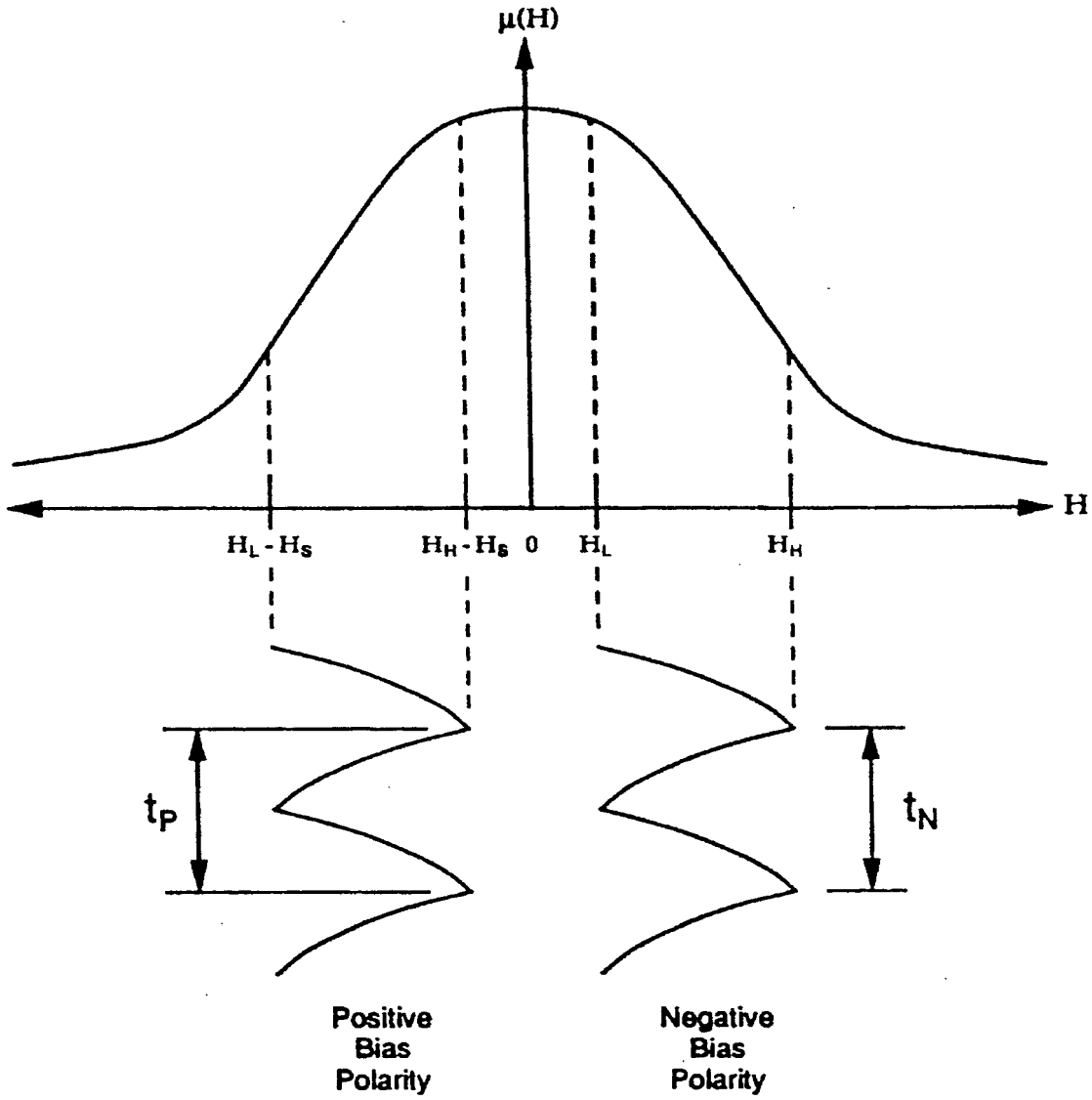


FIG. 1
PRIOR ART

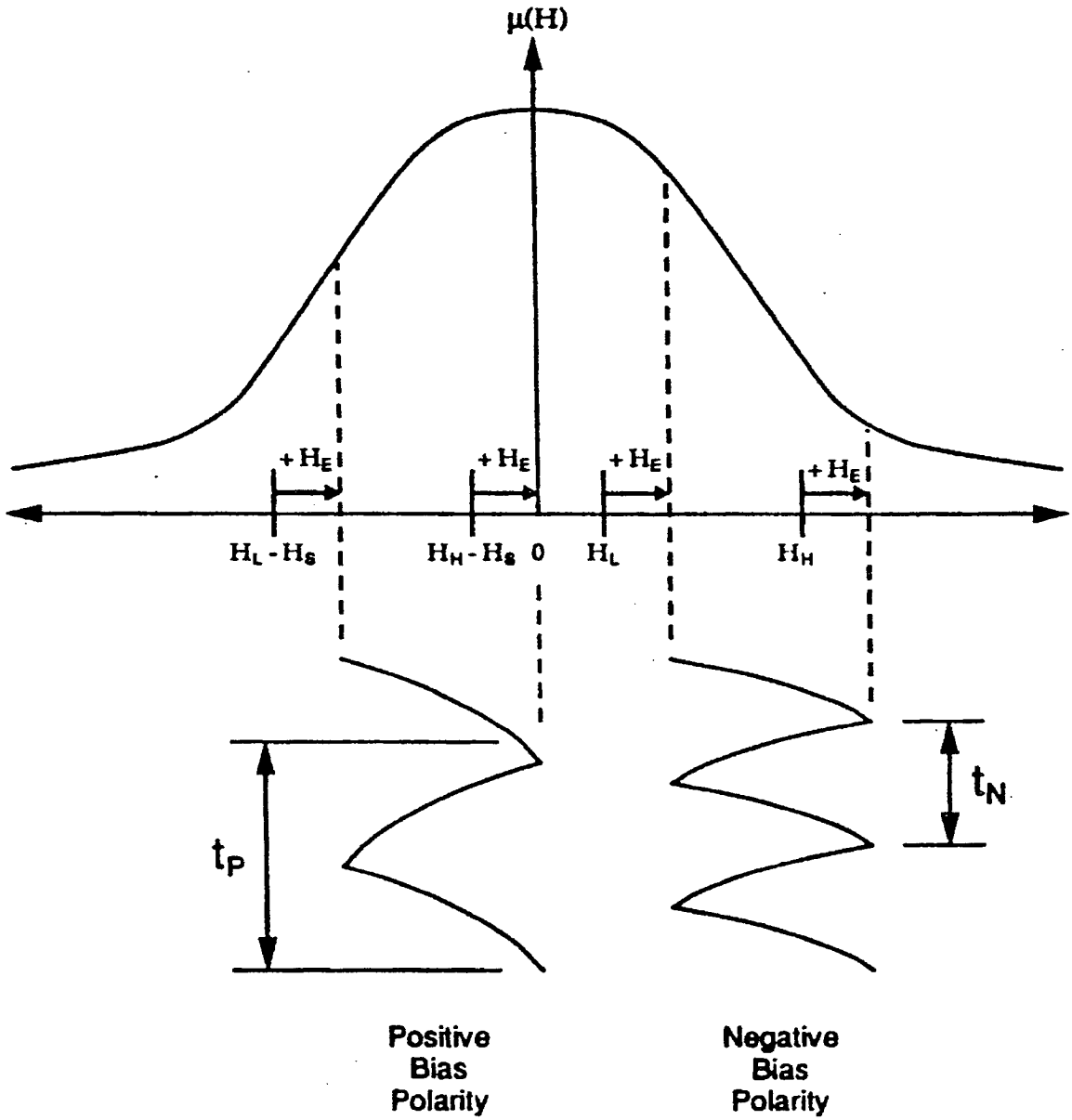


FIG. 2
PRIOR ART

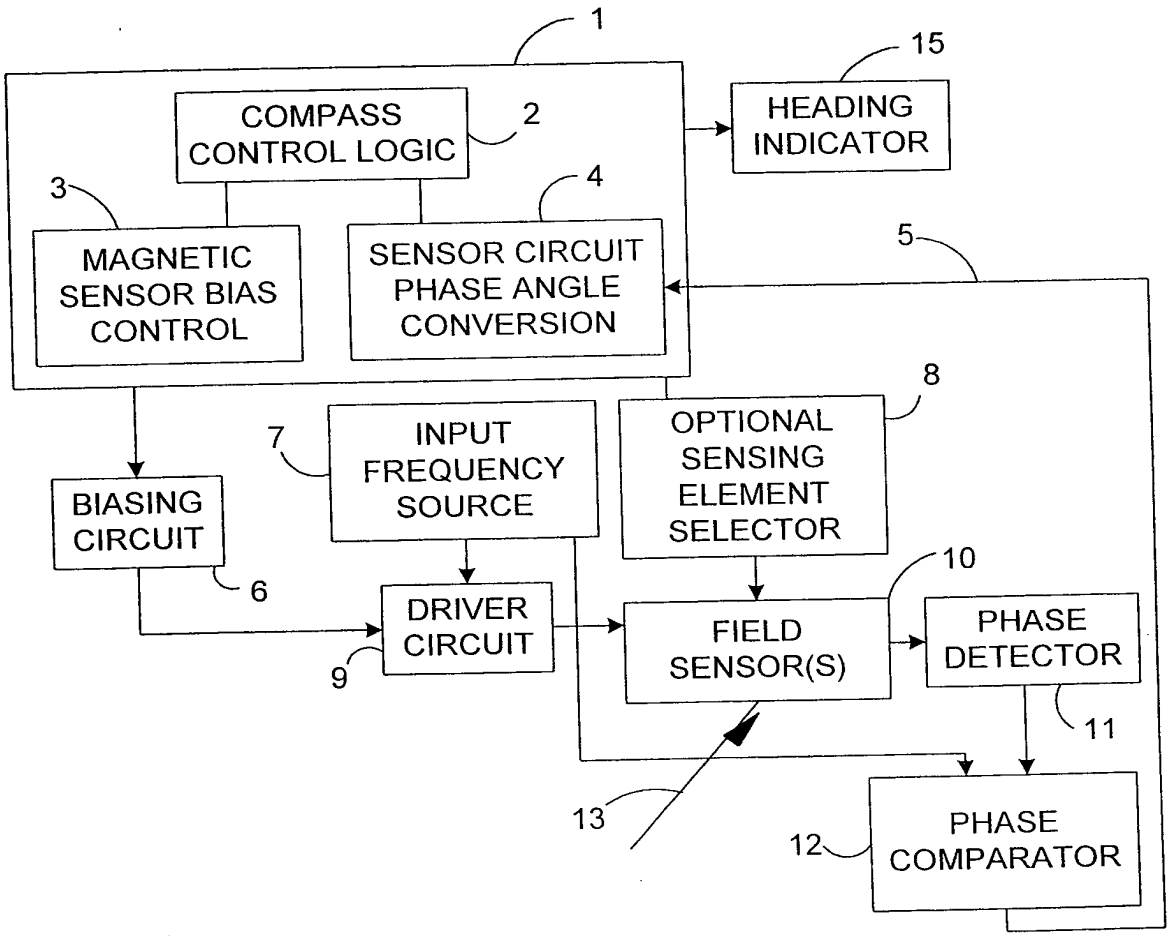

1
15
COMPASS CONTROL LOGIC
2
HEADING INDICATOR
3
4
MAGNETIC SENSOR BIAS CONTROL
SENSOR CIRCUIT PHASE ANGLE CONVERSION
5
8
7
INPUT FREQUENCY SOURCE
OPTIONAL SENSING ELEMENT SELECTOR
BIASING CIRCUIT
6
10
DRIVER CIRCUIT
9
FIELD SENSOR(S)
PHASE DETECTOR
11
13
12
PHASE COMPARATOR

FIG. 3

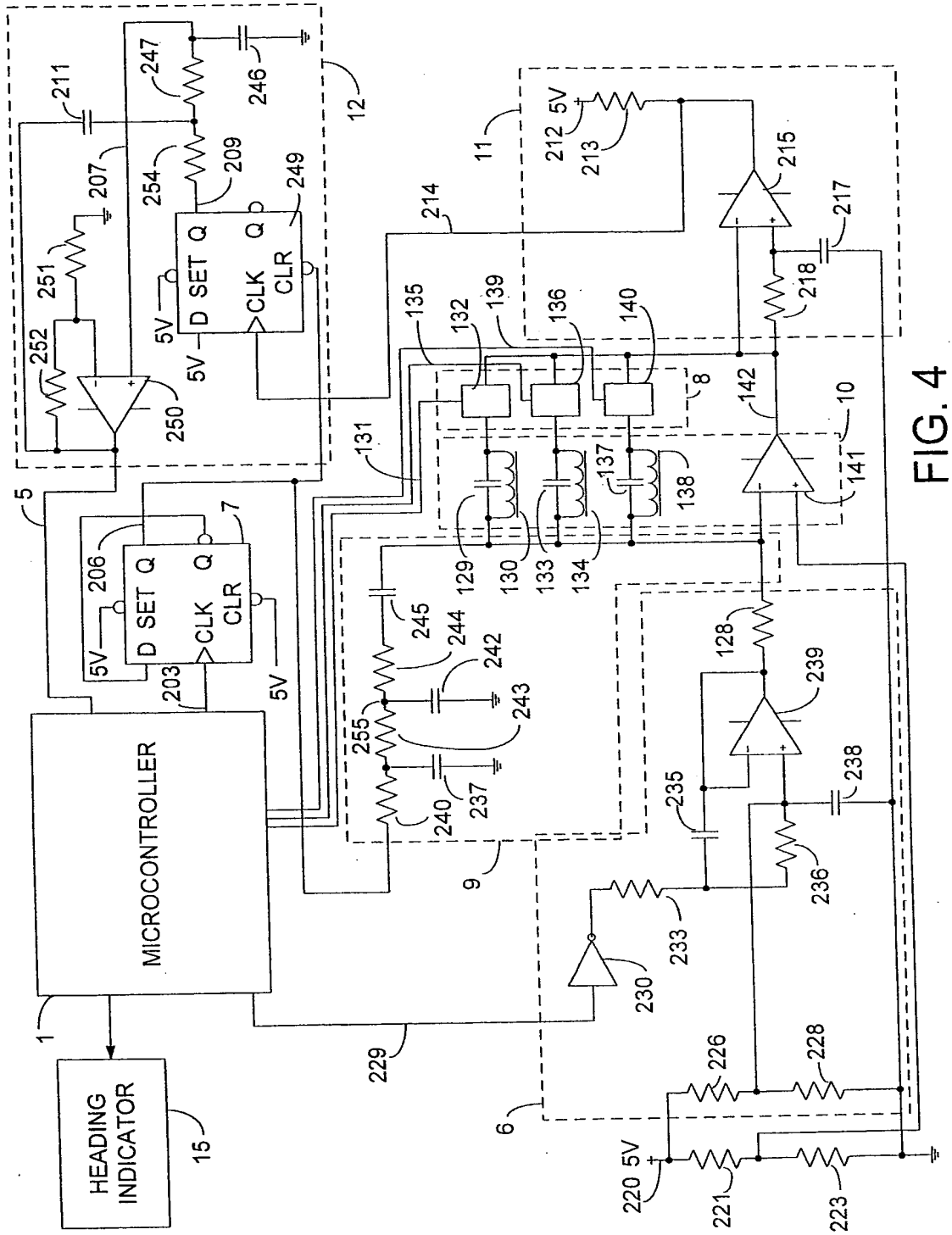


FIG. 4

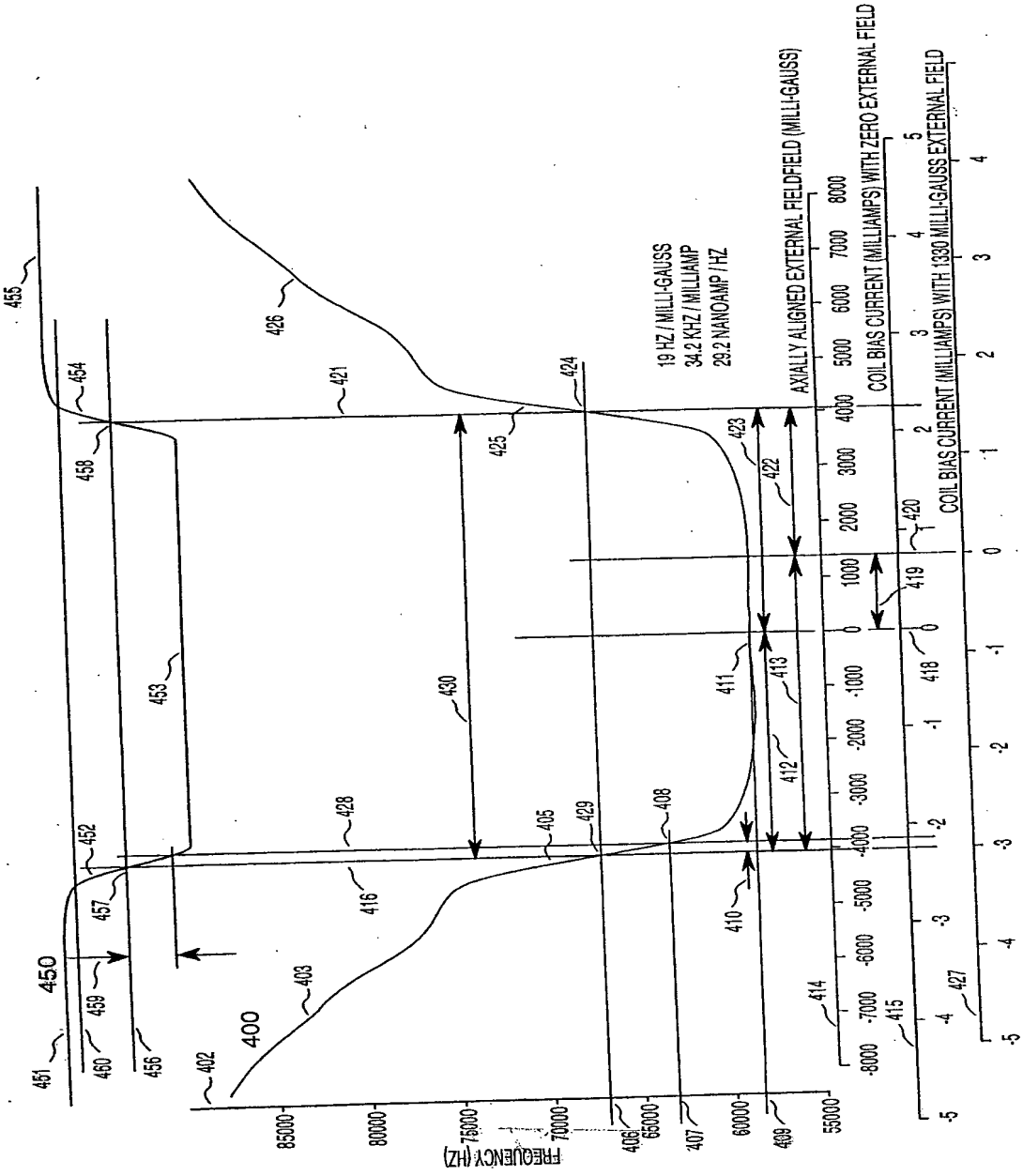

400
450
FREQUENCY (HZ)
85000
80000
75000
70000
65000
60000
55000
19 HZ / MILLI-GAUSS
34.2 KHZ / MILLIAMP
29.2 NANOAMP / HZ
AXIALLY ALIGNED EXTERNAL FIELDFIELD (MILLI-GAUSS)
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
-5000
-6000
-7000
-8000
COIL BIAS CURRENT (MILLIAMPS) WITH ZERO EXTERNAL FIELD
5
4
3
2
1
0
-1
-2
-3
-4
-5
COIL BIAS CURRENT (MILLIAMPS) WITH 1330 MILLI-GAUSS EXTERNAL FIELD
402
403
405
406
407
408
410
411
412
413
414
415
416
418
419
420
421
422
423
424
425
426
427
428
429
430
451
452
453
454
455
456
457
458
459
460

FIG. 5

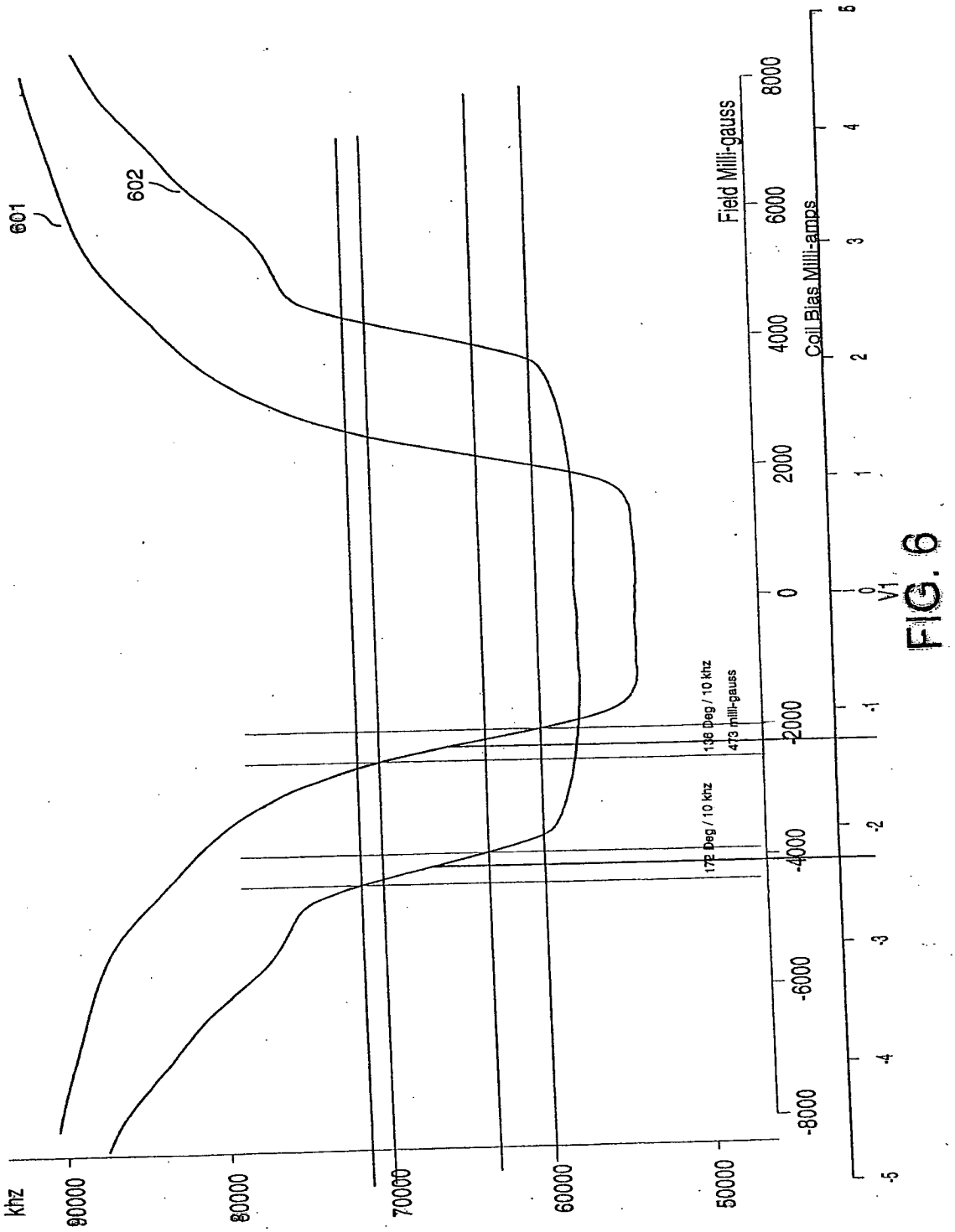

601
602
khz
90000
80000
70000
60000
50000
Field Milli-gauss
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
Coil Bias Milli-amps
5
4
3
2
1
0
V1
-1
-2
-3
-4
-5
138 Deg / 10 khz
473 milli-gauss
178 Deg / 10 khz

FIG. 6

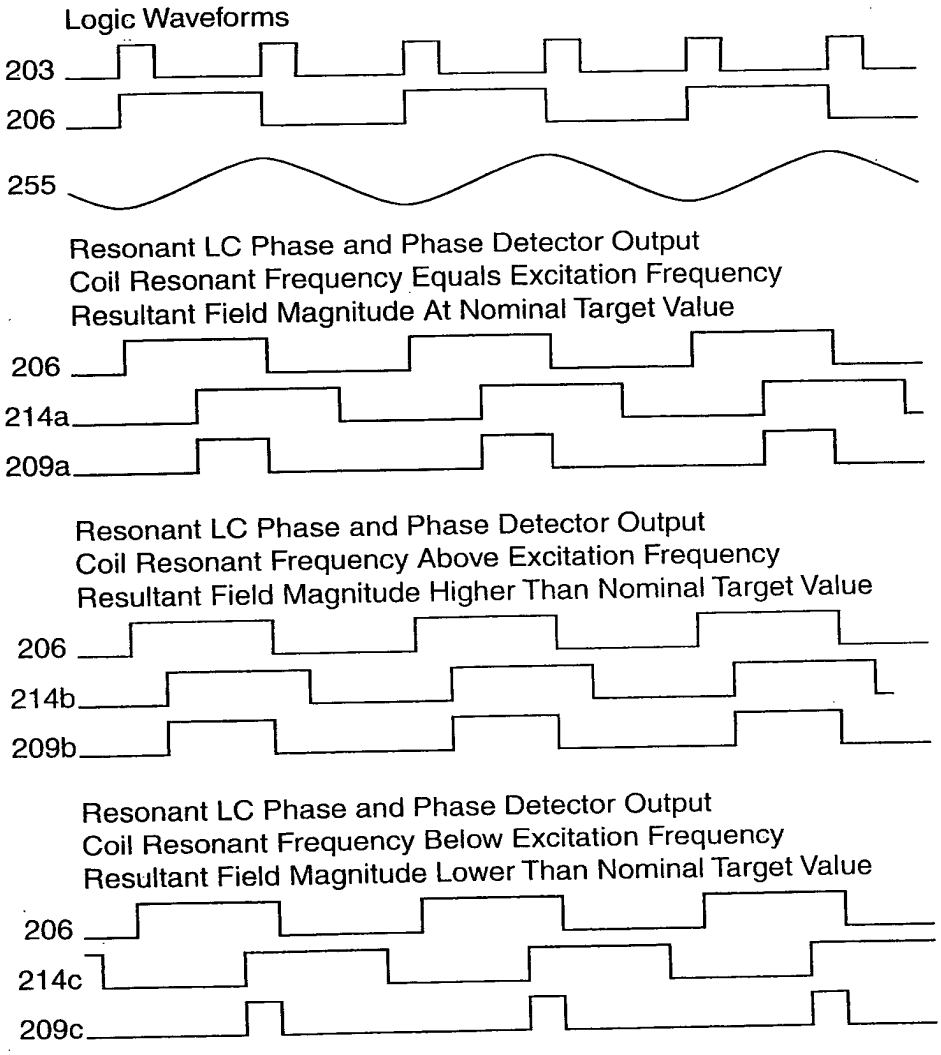

Logic Waveforms
203
206
255
Resonant LC Phase and Phase Detector Output
Coil Resonant Frequency Equals Excitation Frequency
Resultant Field Magnitude At Nominal Target Value
206
214a
209a
Resonant LC Phase and Phase Detector Output
Coil Resonant Frequency Above Excitation Frequency
Resultant Field Magnitude Higher Than Nominal Target Value
206
214b
209b
Resonant LC Phase and Phase Detector Output
Coil Resonant Frequency Below Excitation Frequency
Resultant Field Magnitude Lower Than Nominal Target Value
206
214c
209c

FIG. 7

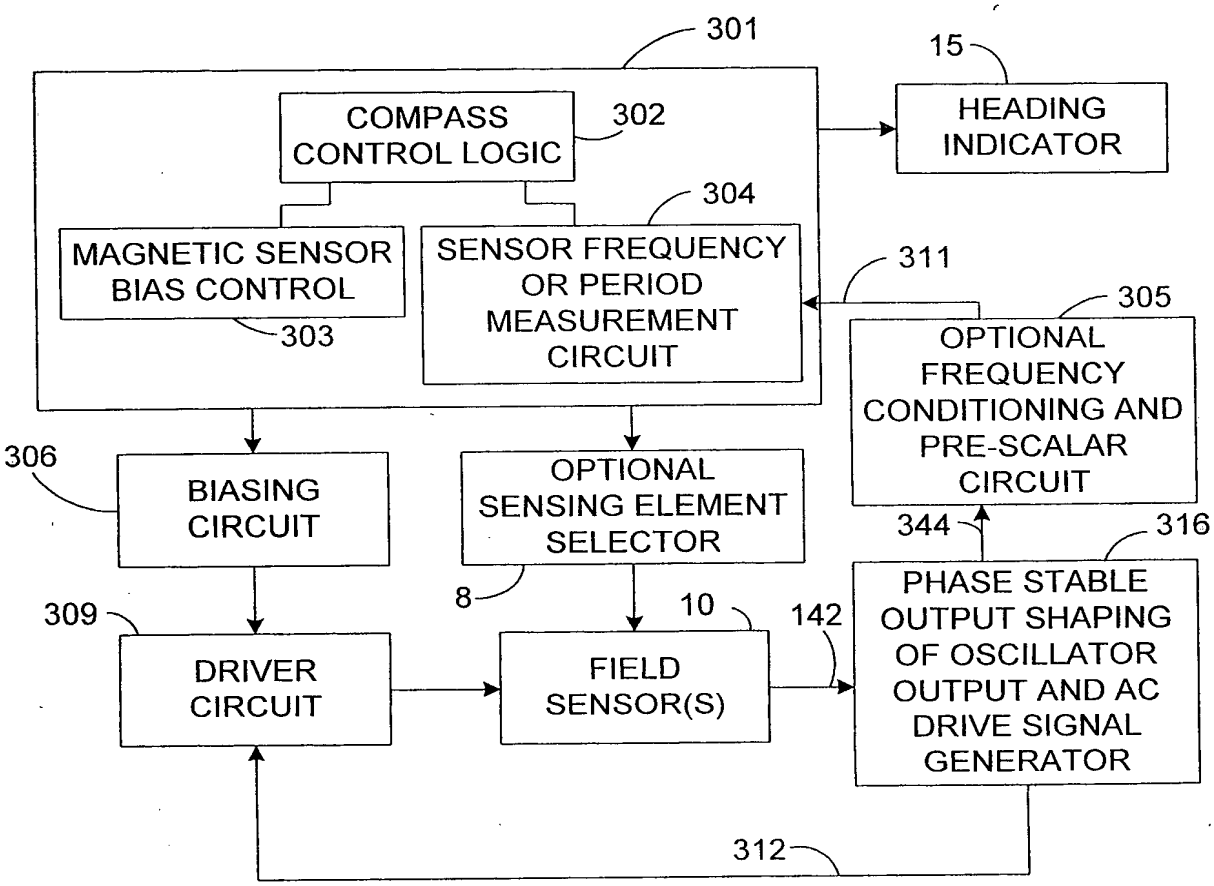
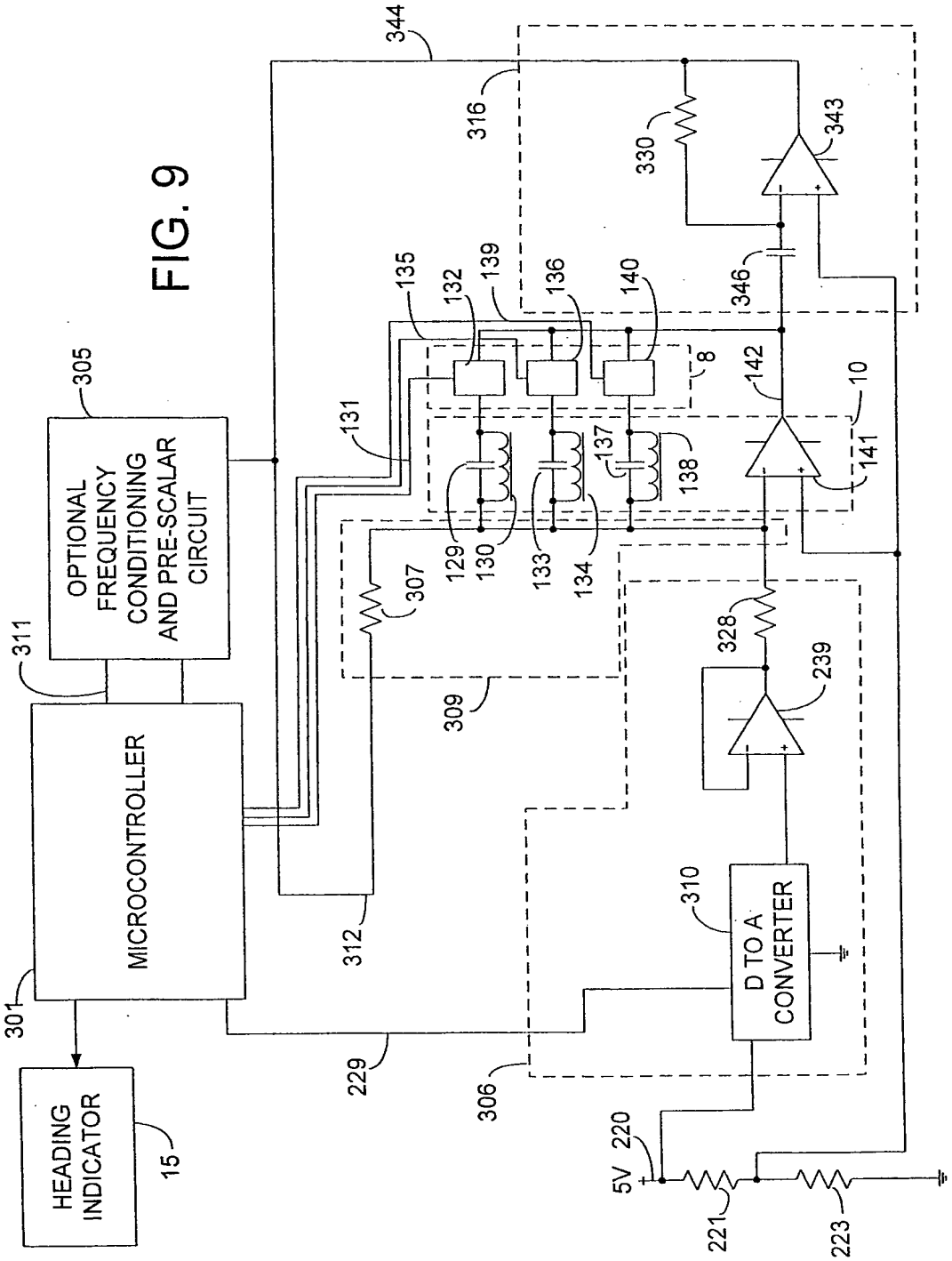

301
15
COMPASS CONTROL LOGIC
302
HEADING INDICATOR
304
MAGNETIC SENSOR BIAS CONTROL
303
SENSOR FREQUENCY OR PERIOD MEASUREMENT CIRCUIT
311
305
OPTIONAL FREQUENCY CONDITIONING AND PRE-SCALAR CIRCUIT
306
BIASING CIRCUIT
OPTIONAL SENSING ELEMENT SELECTOR
344
316
PHASE STABLE OUTPUT SHAPING OF OSCILLATOR OUTPUT AND AC DRIVE SIGNAL GENERATOR
8
10
142
309
DRIVER CIRCUIT
FIELD SENSOR(S)
312

FIG. 8

FIG. 9


344
316
330
343
346
135
132
139
136
140
8
142
10
131
141
137
138
129
130
133
134
307
328
239
309
305
OPTIONAL FREQUENCY CONDITIONING AND PRE-SCALAR CIRCUIT
311
MICROCONTROLLER
312
310
D TO A CONVERTER
301
229
306
HEADING INDICATOR
15
5V
220
221
223

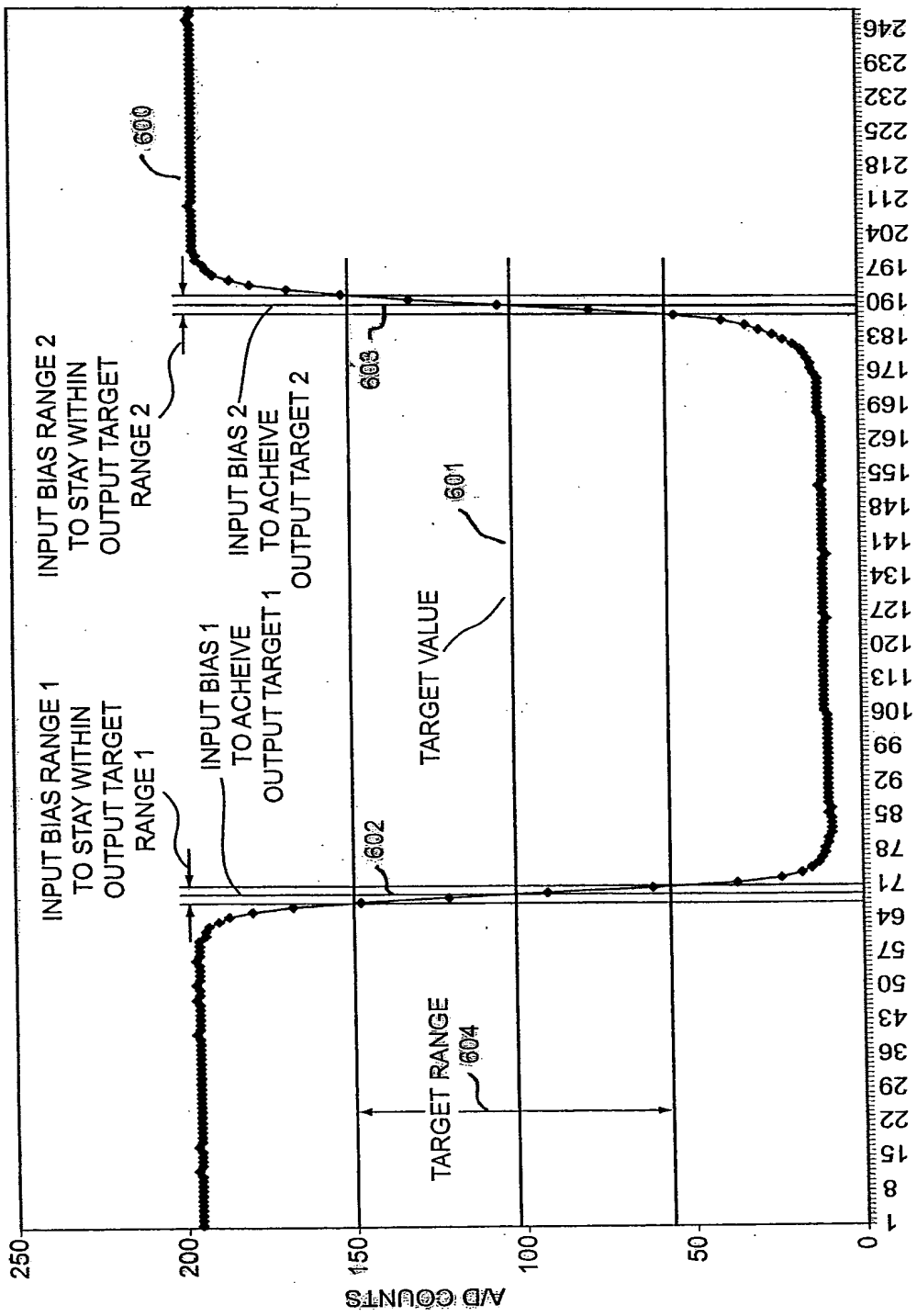

A/D COUNTS
250
200
150
100
50
0
BIAS PWM VALUE
1
8
15
22
29
36
43
50
57
64
71
78
85
92
99
106
113
120
127
134
141
148
155
162
169
176
183
190
197
204
211
218
225
232
239
246
600
601
602
603
604
INPUT BIAS RANGE 1 TO STAY WITHIN OUTPUT TARGET RANGE 1
INPUT BIAS 1 TO ACHEIVE OUTPUT TARGET 1
INPUT BIAS RANGE 2 TO STAY WITHIN OUTPUT TARGET RANGE 2
INPUT BIAS 2 TO ACHEIVE OUTPUT TARGET 2
TARGET VALUE
TARGET RANGE

FIG. 10

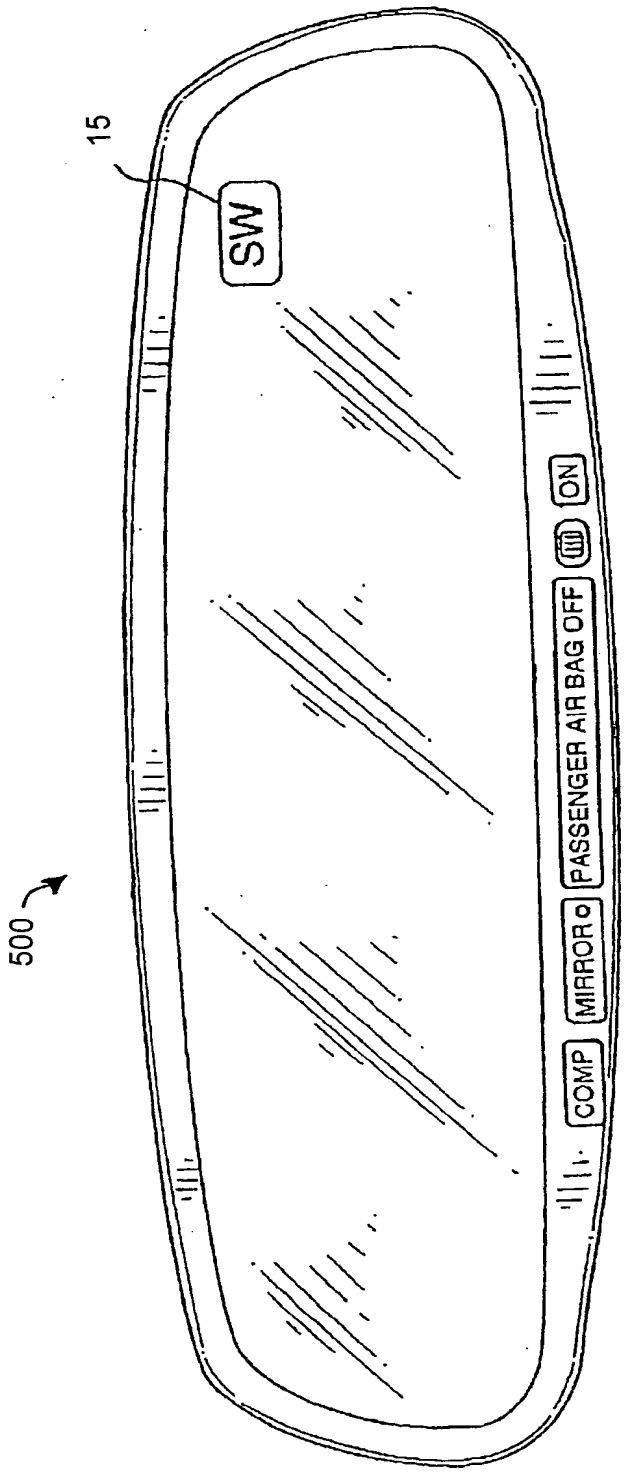


FIG. 11